AMATEUR RADIO

Published in the interests of the Wireless Institute of Australia. Official Organ of all Divisions of the W.I.A. and R.A.A.F.W.R.

PRICE 6d

DECEMBER, 1939

AMATEUR RADIO

Published in the Interests of Radio Amateurs and Experimenters throughout Australia.

VOL. 7 No. 12. 1st DECEMBER, 1939

OUR ORGANISATION

Publishers.—
WIRELESS INSTITUTE OF AUSTRALIA
(Victorian Division)
191 Queen Street, Melbourne, C.1.

Editorial Department.—
W. R. GRONOW (VK3WG),
Editor.

R. H. CUNNINGHAM (VK3ML)
Technical Editor.

C. SERLE (VK3RX)
Notes Editor.

V. E. MARSHALL (VK3UK)
Compilation.

H. N. STEVENS (VK3JO)
Distribution.

L. T. POWERS (VK3PS)
Secretary.

Advertising Department.—
BEDGGOOD ADVERTISING CO.,
129 William Street, Melbourne.
Phone: MU 4046

Sydney Representative—
J. H. FRASER
8 Deakin Avenue, Haberfield. UA 1725.

Perth Representative:—
R. H. ATKINSON,
27 Rathay Street, Victoria Park.

Printers.—
H. HEARNE & CO. PTY. LTD.,
285 Latrobe Street, Melbourne, C.1.

Accounts Department.—
LARGE & POWERS,
Chartered Accountants (Aust.),
422 Collins Street, Melbourne.

MSS and Magazine Correspondence should be forwarded to The Editor, "Amateur Radio," Box 2611W, G.P.O., Melbourne.

CONTENTS.

DIVISIONAL ADDRESSES.

FEDERAL HEADQUARTERS:
BOX 2611W, G.P.O., MELBOURNE

NEW SOUTH WALES:
BOX 1734JJ, G.P.O., SYDNEY.

VICTORIA:
BOX 2611W, G.P.O., MELBOURNE.

QUEENSLAND:
BOX 1524V, G.P.O., BRISBANE

SOUTH AUSTRALIA:
BOX 284D, G.P.O., ADELAIDE.

WESTERN AUSTRALIA:
BOX N.1002, G.P.O., PERTH.

TASMANIA:
BOX 547E, G.P.O., HOBART.

Subscription Rate is 6/- per annum in advance (post paid).

NOTE.—Advertisers' change of copy must be in hand not later than the 20th of the month preceding publication, otherwise the previous month's copy will be reprinted.

EDITORIAL

"W.I.A. WAR BULLETIN."

Here is the news!

Federal Executive applies to P.M.G. Dept. for U.H.F. allocation.

After discussion with Chief Inspector, Wireless F.H.Q. has made formal application for re-issue of experimental licenses throughout Australia, for frequencies of 112 MC and above—Power limit 25 watts.

Non-members of W.I.A. endorse action to restore licenses.

Realising value of Institute as representative Amateur Body, non-members wholeheartedly support Institute's action to obtain re-issue of Experimental Licenses.

N.S.W. Division propose 5 metre relay.

..Stations every 30 miles to provide Interstate relay for emergency communications has been mooted by Sydney H.Q.

S.A. Division running Commercial Classes as well as A.O.C.P.

For details see Divisional Notes. Classes enthusiastically supported by P.M.G.'s Dept.

Unofficial Report from Air Force Officials lauds amateurs in R.A.A.F.

High praise for the efficiency of Members of the Air Force Wireless Reserve, who have been called up, has been given from all States.

Every man, without exception, was able to go straight onto handling traffic without further training, and nothing but praise for their efficiency has been heard from all quarters.

Institute's National Survey will be Permanent Record of Amateur's Worth.

A survey of amateur's serving in the Army, Navy and Air Force, is being made in all States and will form a valuable record of the amateur's part in war time. Don't neglect to fill in and return YOUR form.

Navy makes bid for Amateur's Services.

The Secretary of the Naval Board has asked us to let members know that applications are invited from all amateur operators, who can do 20 w.p.m., to join Navy.

Work of Hams in Services shows need for universal traffic handling after War.

If traffic handling had been permitted before the war, we should not have to chronicle the case of one ham who could copy 25 w.p.m. in his head, but could only write down 10 w.p.m. accurately when tested on enlistment.

Reduced subs and Xmas Hampers for hams on Active Service.

N.S.W. Headquarters are discussing plans to provide hampers at Xmas to hams with the three services. Most Divisions are promoting a move to reduce subscriptions for these members when they are on active service.

Merry Xmas to all our readers, and our sincere thanks to all contributors for their support during the year.

A Review of Radio Receivers

By Courtesy of the Amalgamated Wireless Valve Co. Pty. Ltd.

(H) Volume Control.—The function of a volume control, or more correctly "gain control" is to vary the overall gain of a receiver to produce the required output from different input signals. A volume control should satisfy two important requirements. Firstly it should be in a position such that there is no possibility of overloading the earlier stages. Secondly that it should reduce as quickly as possible the background noise in the receiver.

One of the earliest forms of control was a rheostat in series with some of the filaments. This is not used to-day because of distortion as well as the time delay as filaments heat up or cool down. It is of course out of the question with indirectly heated types.

Following the introduction of tetrode and pentode valves, some attempts were made to use variable screen voltage, but although satisfactory in the reecivers to which it was applied, the range of control is insufficient for more sensitive receivers. The screen grid, having a sharp cut-off characteristic, is critical in setting at low screen voltages. Again any attempt to secure large voltage outputs at such settings introduces considerable distortion.

Modern practice is almost without exception to control gain by means of control grid bias, as applied to variable-mu or super-control valves. With sharp cut-off valves such as 24A, 57, 6C6, 32 and 1K4 the gain can be controlled to a certain extent, but once the bias has reached a certain critical value distortion rises rapidly and renders further control useless. With variable-mu valves such as the 35, 6D6, etc., the grid is so designed that the mutual conductance (which governs the gain) slowly decreases with increasing bias, and allows the valve even to attenuate without serious distortion.

In a normal pentode valve, increasing the grid bias tends to decrease screen (and plate) current. If the screen supply is badly regulated, as would occur with a single series feed resistor, the screen voltage rises as the control grid bias is increased, and tends to lengthen the cut-off characteristic. This effect has at times been used to control the gain of a sharp cut-off valve, and is sometimes used in the I.F. stages of receivers having at least two other controlled stages. With a varible mu-valve it is normally undesirable to increase further the already substantial cut-off bias which is required, and the screen supply should be reasonably well regulated. Normal practice is to use a 25,000 ohm voltage divider across the high tension supply.

The screen current of a pentagrid converter remains fairly constant with varying bias, and if supplied in parallel with other screens exerts a useful stabilising influence.

The foregoing remarks apply of course whether the bias is applied directly to the grid, or through a variable cathode bias resistor.

(I) Automatic Volume Control (A.V.C.).—A.V.C. is a circuit arrangement which reduces the gain of the receiver in proportion as the strength of the income signal increases. The result is to cause all stations to be heard at about the same volume. The majority of A.V.C. circuits depend for their operation upon a diode rectifier.

Figure 4 shows a simple diode detector arranged to provide, in addition to detection, A.V.C. voltages. When a carrier is tuned in alternating voltages at intermediate frequency appear across the secondary of the I.F. transformer. Each time

that the diode plate swings to a positive peak a flow of current occurs through the diode, the secondary of the intermediate frequency transformer and resistor R2. The direction of the current is such that each positive swing on the diode plate causes a negative potential to appear at point A. If we connect across R2 a condenser C2 of sufficient capacity, it will exert a storage effect and tend to keep a constant voltage at point A. When the amplitude of the carrier is varied by modulation at a frequency normally much lower than the intermediate frequency, the value of C2 can be so adjusted as to remove practically all the carrier frequency from R2 while still allowing the voltage across it to vary at the modulation frequency. If therefore R2 is a potentiometer connected as shown we can select from the tapping the voltage necessary to excite the audio amplifier. In practice rather more filtering is necessary to remove from the amplifier all traces of high frequency. The presence of high frequency in the audio amplifier is usually manifested as an unusual "liveness" of the speaker lead, or sometimes as a tendency to howl.

We have seen that at point A there is a D.C. voltage dependent on carrier input, but subject to variation at modulation frequencies. If R1 and C1 are connected as shown, and the time constant made sufficiently long, it is possible to obtain at point C an unvarying voltage which can be applied to the grids of the variable-mu valves for purposes of control.

Without entering into too much detail the A.V.C. voltage, for all normal requirements, must be applied to at least two and preferably three stages in the receiver. In a 5 valve receiver without an R.F. stage the bias must therefore be applied to the converter and intermediate frequency amplifier. Where an R.F. stage is available recommended practice is to apply the A.V.C. to all three stages (R.F., converter, and I.F.) on the broadcast band but to the R.F. and I.F. only on short-waves. With a 6K8-G converter operated on specified conditions, A.V.C. may be applied to the converter without introducing trouble due to frequency drift.

From figure 4 and the associated discussion it can be seen that any signal, no matter how weak, will cause a voltage drop to appear across R2 and a slight negative bias to appear at the grids of the amplifying valves. The receiver therefore tends to lose sensitivity in the presence of a weak signal, or indeed, in the presence of background noise. It is highly desirable therefore to have some delay effect such that the sensitivity of the receiver remains unaltered until signals exceed some pre-determined limit.

If, in figure 4, cathode of the

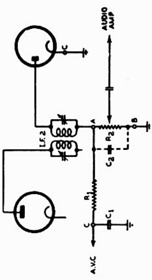


FIG. 4

diode is made positive by say 3 volts in respect to earth, or point B is made negative by the same amount in respect to earth, the desired effect will be had in that no current can flow in the diode circuit till the peak value of the incoming wave exceeds this "delay" voltage. Where, however the same diode is used for detection and A.V.C. as in this diagram, the application of such voltage cripples the detecting action and renders the circuit impracticable. For delayed A.V.C. two diodes are necessary. Where, as is common practice, the diodes are included in the same envelope as a voltage amplifier, the delay may be simply obtained by utilising the voltage drop in the cathode bias resistor. The two to three volts thus obtainable are approximately the optimum dely voltage for average receivers.

Figure 5 shows a satisfactory delayed A.V.C. system.

An important feature of A.V.C. systems is the time constant, or in other words the time taken for the bypass condensers to charge or discharge through the feed resistors. Excessive values of condensers (or resistors) will not allow the receiver to follow fast fading as encountered on the short-wave bands. In addition the receiver tends to be sluggish to handle in that an appreciable time elapses before the receiver recovers full sensitivity after having been tuned to a powerful station. The lower limit is set by two considerations. The first is that the time constant must be long enough so as not to respond to the lowest modulation frequency. Secondly in the majority of circuits the bypass condensers are effectively in series with the tuning capacity across the coil, and small values tend to restrict the tuning range. The values shown in figure 5 are a happy medium between the two requirements.

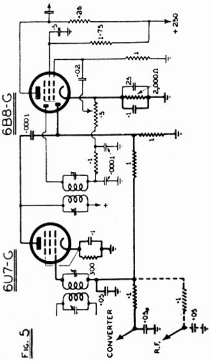


FIG. 5

In figure 5 it will be seen that the A.V.C. diode is fed from the plate of the last intermediate frequency amplifier. This method has two ad-

vantages over the scheme of feeding it from the detector diode. The first is that the available voltage at the plate is higher than at the detector diode, so that the A.V.C. system is improved. The second is that it minimises the shunting effect on the detector diode and hence the distortion caused by such shunting.

Amplified A.V.C. takes two general forms, either a special valve to amplify the signal before rectification or a D.C. amplifier to magnify the actual D.C. bias. Amplified A.V.C. is a highly desirable feature, but is seldom seen in household receivers due to the additional cost involved.

An important point to watch in A.V.C. circuits is that the standing bias on the controlled valves, whether derived in their own cathode circuits or from the A.V.C. return, corresponds to the rated value.

Another important consideration in the effective operation of an A.V.C. system is the regulation of the screen supply, as has already been mentioned in section H. There is one important exception to this general statement. When it is desired to enable the receiver to operate without appreciable distortion on very strong signals the screen of the I.F. amplifier valve may be supplied through a series resistance from the full voltage. When the bias rises on a local station the screen voltage also rises and tends to give the valve a more linear characteristic. This action however materially affects the A.V.C., and the arrangement is not recommended except in cases where there are two other controlled stages having good screen regulation.

When a receiver is fitted with A.V.C. some form of tuning indicator is highly desirable. Many complaints of distortion and harsh tone are directly due to incorrect tuning. Many mechanical devices have been introduced from time to time, generally operated by the change of plate current in one or more of the controlled valves. The majority of receivers nowadays use an electron-ray tuning indicator such as type 6G5 or 6U5. Early samples of these indicators were sometimes unreliable but structural alterations have greatly improved the uniformity and life. Anode supply voltage is not critical, but target supply should never exceed maximum ratings. It is advisable rather, to operate with no more volts on the target than necessary for adequate brilliance (say 180 to 200 volts).

(J) Push Button Tuning.—The latest trend in rceiver design is the provision of push-button tuning. The systems employed may be divided into two main classes.

In the first, some form of multipole switch disconnects the gang condenser from the aerial and oscillator coils and substitutes one of a number of pre-set trimming condensers. Such an arrangement demands from both coil and condenser extreme stability against mechanical shock and temperature change, if anything like satisfaction is to be had. The oscillator circuit is of course far more important in this respect than the aerial circuit. Early attempts to use conventional bakelite mounted, mica dielectric trimmers almost invariably met with failure. Of late some manufacturers have achieved a measure of success by using carefully designed mica trimmers mounted on trolitul bases and shunted, where necessary, by fixed condensers having low temperature characteristics. Other manufactureres have discarded variable capacity tuning in the oscillator circuit and employ the required number of separate resonant circuits, each one consisting of a small fixed condenser shunted across a variable inductance iron-core coil. Such an arrangement can be made extremely stable if the temperature co-efficients of coil and condenser are arranged to be equal and opposite.

The other general classification refers to systems which, either by a system of levers or a small electric motor, rotate the gang condenser to a predetermined position. Problems which arise are therefore of mechanical nature, although effects of temperature must still be considered in design.

It would appear that in existing systems slight readjustment may be necessary on at least some stations about every six months. The majority of these receivers are accompanied by detailed instructions for adjustment and the job of the serviceman should not be very difficult.

Automatic frequency control has been used in a number of the larger receivers in this country, but such a subject is of a specialised nature and beyond the scope of this present treatment.

DETECTORS AND AUDIO AMPLIFIERS.

(A) DETECTORS.—It is the function of the detector in a receiver to rectify the voltages of carrier frequency developed across the tuned circuits of the R.F. stages, and to pass on to the audio amplifiers the modulation components of the carrier.

One form of detector which was popular in early broadcast receivers was the grid-leak or "leaky grid" type, using a small triode valve as shown in Fig. 1. As the name implies, rectification (or detection) is effected in the grid circuit, in a manner which closely resembles that of the familiar diode detector.

The grid is returned to the cathode, or in the case of a directly heated valve to the positive side of the filament. Under such conditions, a small positive voltage applied to the grid causes a flow of current in the grid circuit. When a carrier is tuned in, an alternating voltage appears across the tuned circuit and is impressed on the grid. As each positive half cycle approaches its peak value, grid current flows through the grid resistor in such a direction as to cause a negative bias to appear on the grid. Since the grid condenser C1, is shunted across R1, it becomes charged by these impulses and tends to maintain on the grid a negative voltage very nearly equal to the peak value of the input voltage. Thus, in the case of a carrier of constant amplitude, there appears at the grid a negative bias, together with a certain amount of rectified carrier voltage. When the carrier is modulated at an audio frequency (at which frequency the storage effect of C1 is very small), the grid voltage consists of the negative bias, an audio voltage component and a certain amount of rectified carrier voltage.

The A.F. and R.F. voltages are amplified by the triode in the normal manner and appear in the plate circuit. The higher frequency voltage is prevented from entering the audio amplifier by the R.F. choke and associated bypass condenser. Radio frequency bypass condensers in such circuits should be no larger than necessary, since excessive values seriously attenuate the higher modulation frequencies.

By feeding back a proportion of the carrier voltage into the grid circuit (i.e., by "reaction"), it is possible to realise much higher detector sensitivity than would otherwise be possible.

The plate load of a grid-leak detector usually consists of the primary of an audio transformer. Since with weak signals the negative grid bias is very small, the plate supply voltage has to be reduced sufficiently to limit the plate current under such conditions to a safe figure. Excessive plate current may damage the primary winding of the transformer, and/or cause damage to the valve. A supply voltage between 20 and 100 volts is satisfactory for most valves.

The distortion introduced by a grid-leak detector is appreciable in most cases. With small input voltages it is caused by the non-linear relationship of applied grid voltage to grid current. If the input is increased sufficiently to minimise this effect, the bias developed is too great for the valve to amplify high percentages of modulation without distortion.

Grid-leak detectors are now seldom used in modern receivers where detector linearity is of far more consequence than detector sensitivity.

The grid-leak detector has been largely superseded by the anode bend detector, which in its usual form consists of a triode, tetrode or pentode valve, biased almost to plate

current cut-off ("Lower Bend Detection"). The high bias required is usually obtained by means of a large bias resistor in the cathode circuit, as shown in Fig 2. This bias resistor is bypassed by a condenser of suitable capacitance both for R.F. currents of carrier frequency and A.F. currents of modulation frequencies.

When an alternating voltage is impressed on the grid, each positive half cycle produces an increase in plate current, while little change is produced by the negative half cycle. When the input voltage is an amplitude-modulated carrier, the plate current consists essentially of a series of undirectional current pulses varying with the modulation depth, and at modulation frequency, together with a D.C. component, the average value of which is dependent on the carrier input voltage. These current pulses produce across the plate load resistor (RL) a series of voltage pulses (at carrier frequency), the peak values of which vary according to the modulation.

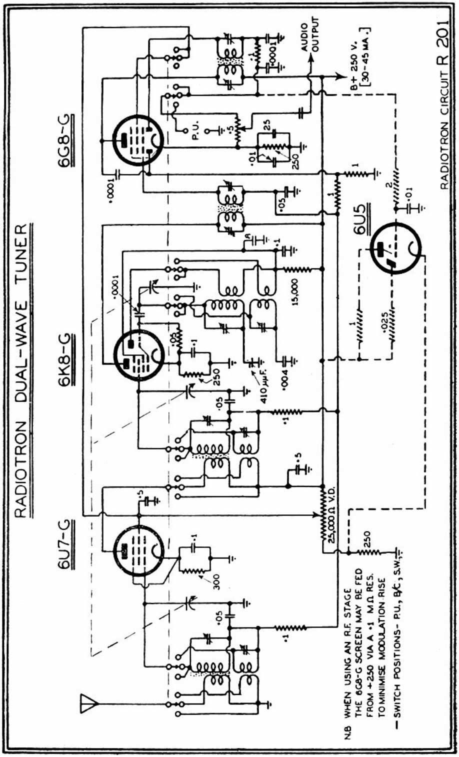
The plate bypass condenser C1 provides a low impedence path to the cathode (or filament) circuit for current components of carrier frequency appearing in the plate circuit, and, together with the R.F. choke and second bypass condenser C2, prevents the R.F. components of the plate current from reaching the plate load, so that the voltage developed across the latter varies only at modulation frequencies. In this manner, the modulation components of the carrier appear as audio frequency voltages across the plate load of the detector valve, and may then be applied directly to the audio frequency amplifier.

The gain of an anode bend detector may usually be increased by substituting for the plate load resistor a high inductance audio choke (shown dotted), which offers a high A.C. load impedance but allows a much higher effective plate voltage to be obtained. It is usually desirable to shunt such a choke with a resistor (e.g., .25 megohm) in order to stabilise the A.C. plate loading of the valve, since the impedance of a choke varies with frequency. In normal broadcast receivers it is doubtful whether the use of a choke justifies its cost.

An anode bend detector is capable of handling relatively large signal

input voltages and imposes comparatively negligible loading on the input circuit. It can be shown, however, that under average conditions it introduces appreciable distortion, although not necessarily sufficient to debar its use in present-day receivers. The use of this type of detector is also restricted by its inability to provide A.V.C. voltages.

A recent development of the anode bend detector, known as the "Linear Reflex Detector," incorrectly though commonly called the "Infinite Im-



pedance Detector," is worthy of note and will be mentioned more fully in a later lecture.

The majority of modern receivers use diode detectors. This form of detector has already been mentioned in connection with automatic volume control, but some repetition is necessary for the sake of continuity.

Fig 3 shows a simple diode detector circuit. When a carrier is receievd alternating voltages at intermediate frequency appear across the secondary of the I.F. transformer. Each time the diode plate becomes positive during a positive half cycle, a pulse of current flows through the diode, the secondary of the I.F. transformer and the load resistance R2. The direction of this current is such that during each positive half cycle, a voltage negative with respect to earth, is produced at point A. If we connect a condenser C2, of sufficient capacitance, across R2 it will exert a storage effect and tend to maintain a constant D.C. voltage at point A. When the amplitude of the carrier is varied by modulation at frequencies normally much lower than that on the carrier (or the I.F.), the value of the C2 can be so adjusted as to remove ,practically all the voltages of carrier frequency from R2, while still allowing the voltages developed across it to vary at modulation frequencies.

In order to obtain sufficient excitation voltage for the output stage, it is usually necessary in practice to incorporate at least one stage of audio amplification between the diode detector and the output valve. When a duo-diode triode or a duo-diode pentode is used, it is possible to obtain (in one valve) detection, first stage amplification and A.V.C. voltage. An alternative scheme is to employ a duo-diode super-control pentode, such as the type 6G8-G (6B7S), and use the pentode section as the last I.F. amplifier. It is then possible to use an efficient pentode, such as type 6J7-G, in the first audio stage and completely isolate the high and low frequency circuits.

Early practice was to connect the grid of the first audio amplifier directly to point A, or in the case of receivers equipped with A.V.C. to a variable tapping on R2. With this arrangement the bias on the first audio amplifier is developed by the diode across the load resistor (R2), and is therefore of a very variable nature, being dependent on both the carrier strength and the position of the tapping. The valve when operated in this manner is said to be "Diode Biased," and the method is only practicable with a valve having a very low amplification factor (e.g., type 55), being quite unsuitable for high-mu types.

Normally it is necessary to use a D.C. blocking condenser (C3) followed by a grid resistor (R3). These constitute an A.C. shunt on the D.C. load resistor (R2), and have a very important influence on the operation of the diode. The ratio of the A.C. to the D.C. loading sets a limit to the depth of modulation of a carrier which the diode is able to handle without serious distortion. In a circuit, such as that shown in Fig. 4, the maximum percentage of modulation which can be handled without appreciable distortion is 33%. At the highest modulation frequencies, where the reactance of the R.F. bypass condenser is appreciable, the distortion is even greater. On peaks of modulation the distortion is very serious and figures of up to 30% can be expected.

The arrangement shown in Fig. 5 is representative of good practice in diode circuit design. It will be seen that the A.V.C. network can have little effect on the detector diode, while the shunting effect of the grid resistor is low, since the volume control is seldom used in its maximum position. Measurements show that the effect of the high frequency bypass condensers specified is not serious for percentages of modulation, which can be expected at higher audio frequencies at which the shunting effect is appreciable.

Continued on page 21.

NOTICE

Don't forget to fill in and return the "Amateur" Survey Form enclosed with this issue.

Returns are desired from all Australian Licensed Experimenters.

Resistance Coupled Amplifiers

By J. H. Fraser, A.M.I.R.E. (Aust.), VK2AFJ.

The Author discusses the theory of resistance capacity coupling of amplifiers and then goes on to describe the way to go about designing such an amplifier. He concludes with a few practical tips which should be kept in mind when looking for trouble in the finished amplifier.

GENERAL.

The design of a resistance capacity coupled amplifier is not complicated, and for average performance the design is not critical, but for those who would wish to extend the frequency range at both the low and high frequency ends of the audio spectrum the information in this article may prove helpful.

This type of amplifier has a characteristic which is well known, namely: the capability of amplifying a wide band of frequencies, but another characteristic is that the amplification falls off at low and high frequencies unless special precautions are taken with the choice of resistance and capacitance values to ensure amplification of that wide band of frequencies.

The falling off in amplification at low frequencies is because of the high reactance of the coupling condenser, whilst at high frequencies it is because the tube and stray capacities tend to have a low reactance and thus lower the effective load impedance of the tube.

NOTATION AND FORMULAE.

R_p = plate resistance of the tube.

R_c = plate coupling resistance for the tube

R_g = grid resistance for the following tube

R_a = the value of R_p R_c and R_g in parallel

R_b = the value of R_g inseries with the value of R_p and R_c in parallel

X_c = the reactance of a condenser

X_{cs} = the reactance of the stray capacities

X_{cc} = the reactance of the coupling condenser

C_c = the coupling condenser

C_s = the stray capacities including the output capacity of the amplifier tube and the input capacity of the following tube.

π = 3.1416

f = frequency in cycles per second

$$X_c = \frac{1}{2 \pi F C} \qquad \text{............eqn (1)}$$

ratio of amplification at high frequencies to amplification at medium frequencies.

$$= \frac{1}{\sqrt{1 + \dfrac{R_a}{X_{cs}}}} \qquad \text{.......eqn (2)}$$

ratio of amplification at low frequencies to amplification at medium frequencies.

$$= \frac{1}{\sqrt{1 + \dfrac{X_{cc}}{R_b}}} \qquad \text{............eqn (3)}$$

THEORY.

Reference to Fig. 1 shows a conventional one stage amplifier. Equivalent circuits of Fig. 1 are shown in Figs. 2a, 2b and 2c. Fig. 2a is the equivalent circuit for studying the amplification at medium frequencies, Fig. 2b is that for the high frequencies, whilst Fig. 2c is the equivalent circuit for the low frequencies.

AMPLIFICATION AT MEDIUM FREQUENCIES.—Fig. 2a.—It will be readily realised that the reactance of the coupling condenser C_c can be neglected at these frequencies and the shunting effect of the stray capacities C_s can be neglected too, so the effective load resistance is the sum of the three resistances R_p, R_c and R_g in parallel, i.e., R_a. The amplification at medium frequencies will be taken as a reference point.

AMPLIFICATION AT HIGH FREQUENCIES,—Fig. 2b.—At high frequencies the reactance of the condenser C_c can still be neglected, but the shunting effect of the stray capacities begins to be appreciable, and is the more so the higher the frequency. Thus it will be seen that the stray output capacities limit the high frequency response of an amplifier. This leads to RULE 1, viz. :—The amount by which the amplification falls off at high frequencies is determined by the ratio which the reactance of the shunting capacity bears to the equivalent resistance obtained by combining the plate resistance coupling resistance and grid resistance all in parallel.

AMPLIFICATION AT LOW FREQUENCIES.—Fig. 2c.—The effect of the stray capacities on the output can be neglected at low frequencies, but not so the effect of the reactance of the coupling condenser C_c. At low frequencies this condenser's reactance is so high as to limit the low frequency response considerably. It will be seen from the Fig. 2c that Rg is now in series with Cc and the smaller the value of the resistor Rg the poorer the low frequency response. This leads to RULE 2, viz. :—The amount by which the amplification falls off at low frequenc-

ies is determined by the ratio of the resistance of the coupling condenser to the equivalent resistance of the grid resistance in series with the parallel combination of the plate resistance and plate coupling resistance.

Equations (2) and (3) are useful for numerically determining the falling off in amplification compared with the amplification at medium frequencies.

100,000 ohms and 500,000 ohms, so that the voltage at the plate of the valve is between 50% and 20% of the available plate supply voltage approximately.

The third step is to choose the values of the GRID RESISTANCE Rg and COUPLING RESISTANCE Cc together, on the basis of the desired low frequency response. This leads to RULE 3, viz. :— the greater the numerical value of the

Internal Plate Resistance Rp.

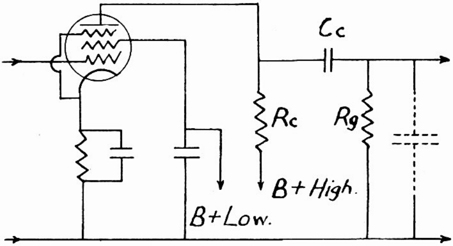


Fig 1.

STEPS IN DESIGN.

The first thing to choose is a SUITABLE TUBE. Sharp cut-off penthodes are most suitable because they give high gain and a better high frequency response. If triodes are required it is better to use a high-mu type than a low-mu type. However care must be taken in ensuring the correct bias for the high-mu types as a variation in a few tenths-of-a-volt can be quite upsetting in performance.

The second step is the selection of the best value of COUPLING RESISTANCE. If all things were equal the higher the value of the coupling resistance the greater would be the amplification, but increasing the plate coupling resistance reduces the voltage at the plate of the tube. It is usual to choose a value of between

product R_gC_c the better the low frequency response. However it is better to use the highest value of grid resistance permitted by the tube manufacturer, under the intended operating potentials.

The fourth step is to ESTIMATE the STRAY CAPACITIES C_s. Work out the reactance their total value has at the desired HIGH frequency and substitute the value in eqn. (2). If the result does not give the desired high frequency response, it will be necessary to REDUCE the value of either or both R_p and R_c, until the desired response is obtained.

It was stated earlier, that increasing the value of R_c improved the gain, thus it will be seen that when R_c is lowered the gain is reduced. And reduced gain is the price that must be paid for a good response characteristic.

PRACTICAL HINTS.

If one desires to use a type 6B7, 6B7S or 6G8G as an audio amplifier in either a receiver or straight amplifier the following procedure should be adopted. Use a 250,000 ohm plate coupling resistance with a power supply voltage of 250. Then apply the following screen and control grid voltages. Use a 1000 volt scale meter for measuring the screen voltage. It is essential that the bias value be adjusted carefully to these values if the GREATEST gain, with the particular screen voltage used, is to be obtained.

Bias	Screen
— 2.5 V	+ 30 V
— 3.2 V	40 V
— 4.6 V	50 V
— 7.8 V	75 V
— 9.3 V	100 V

Fig 2a.

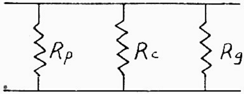


Fig 2b.

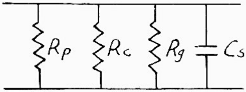
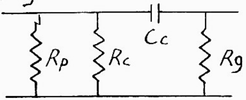


Fig 2c



Only good paper condensers should be used when extending the low frequency response beyond normal. Paper condensers can be used satisfactorily down to 40 cycles and mica condensers will permit of the frequency range being extended to 5 cycles per second.

It is generally undesirable to extend the low frequency response lower than required. This is because such an improvement is of no benefit, and invites trouble from feedback, arising out of common plate impedances amongst other things.

Make sure that you have the full filament voltage on all the amplifier tubes, especially the power output stages. If you have an amplifier with types 6L6, 6V6 or 6Y6 and can't get the full output, then look to their filament voltage first.

When the amplifier happens to be a high gain outfit, then take special precautions to shield the entire first stage COMPLETELY in a 16 gauge brass shield, both top and bottom, and do not use a steel chassis if there is a power or filament transformer on the same chassis. This will ensure both electrostatic and electro-magnetic shielding. Shield the filament leads as much as possible. The entire chassis should be earthed too.

It is considered bad practice to use carbon resistors as plate load resistors. They are a potential source of noise and the noise increases as the current flowing through them increases. The reason for this is because of fluctuations in contact resistance between adjacent granules in the carbon resistor, and is similar in character to the hiss occurring in carbon microphones. The obvious remedy is to use wire-wound resistors for the plate load resistance, or failing that to use carbon resistance of the highest quality only. Such high ohmage wire-wound resistors are rather expensive, but are nevertheless worthwhile incorporating in the first stage of a high gain amplifier. They are obtainable in Australia and are used in pre-amplifiers in Broadcasting tations extensively.

Federal and Victorian QSL Bureau

R. E. Jones, VK3RJ, Federal QSL Manager.

From the month's mail . . . listened on 14 mc few times and heard Ce, Ly, Oz, Pa, it's a shame we can't get amongst them . . . only listened a few times, but heard Oq5ae on fone, and I have to stick at gardening . . . listened on 14 and 28 mc, and Oz, Ly, K7, K4 and others were rolling on the first-mentioned band. We are stiff not being able to have a go at them . . . .

VK's do your stuff. VK has a bad name overseas as regards QSL. Fill in idle periods, bringing your cards up to date. The Bureau still functions for all non-enemy countries, and the rates are the same.

An amended address for the Eire QSL Bureau is: I.R.T.S., QSL Bureau, "Aughnacloy," Killiney, Dublin, Ireland, and the QSL manager is R. D. Mooney.

W.A.C. recommendations for the past few months include VK3GG, 2PF, 2TI, 2RJ, 2PV, 2ACX, 4LZ and 7KR.

Another one for the stamp collector is Pklog, Ong Keh Kong, Malabar Radio, Java, Netherlands East Indies.

Help the QSL manager "enjoy" his inactivity in other directions, by claiming the cards on hand at The Bureau, 23 Landale Street, Box Hill. This is intended to catch the eye of the following VK3's:—

AC, AE, AP, AS, AX, AY, BD, BF, BG, BH, BK, BN, BS, BV, CA, CH, CQ, CU, DI, DJ, DS, DU, EF, EH, EI, EL, ES, EU, EV, EW, EZ, FG, FW, GB, GD, GE, GR, GU, GX, HI, HV, IA, IB, ID, IF, IM, IP, IS, IT, IU, IV, IY, JM, JP, KQ, KT, KY, LF,

Continued on page 16.

DX Notes

By VK3MR.

I notice by the VK5 notes there is somebody like myself with a depraved sense of humour signing themselves "ex-VK5RM." It has been said that great minds think alike! The trouble nowadays is that there is little to relieve the monotony of the European situation which is dished up with the bacon and eggs every morning, very trying on the digestion, too. Pity he didn't take on ham radio when a boy!

Notes are scarce this month, as most of the old reliables have joined up in the R.A.A.F. or the Army and Navy as operators. Your scribe is still practising to pass the 16 w.p.m., as still more are required. Applications for the position of traffic manager are here now assured that Morry can handle the brass. This is my personal recommendation. Our dear old editor has started his funny business again by querying my "selections" in last month's mag. He is quite his old self again now as he has eased his conscience regarding last income tax returns. Added to the list of countries worked we hear from Ted (3QK), who has worked 121 and 108 verified, which is great work for the short time on the air. Ted is now reclining down in Churchill Island, near Phillip Is. (He spells it Phippit Is., but I think his mill slipped). He has everything suited for radio and big Vee beams including 100 ft. high pines. What a blow Ted. He is very pleased with his Centenary certificate. I would like to exchange W cards from any eastern State for one from S. Carolina. A complete set of WAC's will also be offered. Season's compliments to all.

Continued from page 15.

LH, LI, LM, LQ, MJ, NB, NC, ND, NT, OA, OE, OI, OU, OZ, PC, PH, PK, PJ, PL, PV, QE, QG, QT, QZ, RF, RL, RV, SC, SE, SK, ST, TA, TC, TD, TF, TM, TP, TY, UC, UV, UX, VA, VB, VD, VV, VW, VX, VZ, WH, WR, XC, XG, XK, XL, XQ, XR, XU, XZ, YG, YH, ZC, ZD, ZG, ZJ, ZL, ZO, ZS.

Bill Barratt, VK3WT, has moved into civilisation in Geelong, and is anxious to see how the new location works out. He extends a hearty invitation to all hams passing through to look him up.

NORTHERN ZONE NOTES.

By ex-VK3BM.

Many thanks, gang, for FB returns to my requests for dope, the notes forwarded for publication mentioned nearly every member in the zone, but— we will blame Hitler for their non-appearance. One of the many problems to be solved during this war is how a notes correspondent is to get dope from the gang scattered over half the State AND further! without our means of communication? It's up to you chaps to let me know the doings.

3OR Murray responded to the call of the R.A.A.F. WR early in the piece has established himself and family in Melbourne, and is operating at Victoria Barracks.

3KR—Ken left Melbourne to take on talkie operating at Benalla, but soon after received the call and is, we believe, at Point Cook.

3EP—Ted is very busy in Bendigo and missing the chin wags over the air—but aren't we all. Had just completed an fb new rig, too.

3QZ—Graham had started to build his modulator.

3TL—Had an unfortunate fall from a ladder, but is now recovering—bad luck, 0M!

3HX—Left Charlton for address unknown as yet.

3FF—Had only just completed a beautiful new rig, all aluminium rack and panel, and it worked like a dream.

3JG—Had just landed a swag of Bliley Rocks. Plenty of time for yachting now.

3ZK—Will have to complete his affairs by mail!

3EC—Taken up yachting.

3BM—Has tried cinematography and philately, but anyway is too busy with the harvest to be worried.

28-56 MC Notes

A. Pritchard, VK3CP.

We still have our old interest, and although we cannot press the key or warble into the mike, we still hear our numerous old friends in the States, who are coming through very well at present. The CW portion of the band is very lively and gives us plenty of opportunity to keep our code up to scratch. The following are on the job quite often: WILFI, IGBD, 2KZN, 3BKH, 4EED, 4FIG, 5HGD, 6LCP, 7BAA, 8AJE, 8FTM, 9GKZ, showing all districts active, in fact, more so now than before the war. This must be due to the lack of foreign QRM which has taken up the low frequency end of the band.

The phone men have been experimenting with the latest method of modulation, this being the cathode system, and K6PLZ in particular, of 100 WAC's in two years fame, has spent some time with this, and finds that the results are all that could be desired. The main advantage is that less audio is required for 100% modulation of the full carrier available for plate modulation, as compared with the best of grid bias systems, i.e., the class BC amplifier, which compromises a maximum carrier output with a minimum of audio for 100% modulation, but which possesses the disadvantage of requiring considerable reduction of the carrier power.

Other phones coming through well are WIIYE, WIKTF, 2ICL, 6PDB, 7BQX, 8FXM, 9DRQ, not forgetting 'the old faithful' 6POZ, with his 'plumber's delight' 3 element beam.

The beam is of all steel construction with welded joints, the whole system being grounded, and those who are using it are putting through outstanding signals. As no insulators are required with this ideal scheme these sources of losses are completely removed. Several insulatorless beams have been described in Radio (Calif.) for 56 mc., and higher frequencies, but so far as I know, none of these beams have been tried in VK. Talking of antennae, K6QXY has his beam on top of a 40 feet stick of 6 in. x 6in. section and no guy wires.

Two visitors at present in the States are SM5YU and ZLILC, the former speaking excellent English and the latter excellent (?) American.

Those elusive K7's are showing up represented by K7EMN and K7GZH. Experience has shown that, like Europeans, they only come through for a short period of the year. Other countries are represented by KAIME, KAIOZ, XU8AM, ZS6W, HQ5AD (qso'd by J2XA), XEIAM, XEIGL, TI2AV, and CXIFB. Unfortunately, these only provide good hunting for the W's. Fate would predict that we cannot participate.

In the October QST, an article on the series valve noise limiter should give the lads a few ideas on this subject. The limiting valve works in conjunction with the second detector adjusted for infinite impedance detection so that very little change over is necessary to test the idea.

Of the many W's active on 56 mc., one has at last succeeded in contacting all districts. W6GPY and W6ZA have been experimenting on 325 mc., (below I meter) with low power and have established entirely satisfactory phone communication over a path of five miles. Their observations are interesting,—firstly the almost complete lack of auto QRM in receivers, and secondly, that readable signals have been obtained over a similar distance with a hill in between. 112 mc. has previously exhibited similar immunity from the limitations of an optical path.

VK's 3BQ, CZ, and CP, and poppa de EX had hopes of developing the art of portable ham radio on a trip to East Gippsland, which was planned in the early part of the year for November, but such valuable time will now be spent calling CQ's to blondes (auriferous?) and trout, to the accompaniment of mosquito QRM. The boys should return in good health and spirits if Max maintains his customary culinary proficiency as was magnificiently displayed at Torquay.

Divisional Notes

IMPORTANT.

To ensure insertion all copy must be in the hands of the Editor not later than the 18th of the month preceeding publication.

N.S.W. DIVISION.

President: H. F. Petersen, 2HP.

Vice-Presidents: W. G. Ryan, VK 2TI and F. Carruthers, VK2PF.

Secretary: C. Horne, VK2AIK.

Treasurer: H. Ackling, VK2PX.

Editor of Notes for this Division: J. H. Fraser.

Next Meeting: Thursday, December 14th.

Interstate and Country Visitors should ring FX 3305.

Well, here I am, back on the job of writing these notes. Last month I was in camp and I left the job to 2TI, and I would like to take this opportunity to thank him for doing the Magazine Manager's job for the month. I went to Nowra Showground for the thirty days' camp with the 1st Cavalry Division Signals. There were quite a few Hams in camp, including 2UP, 2RF, 2ALG, 2ACS, Ex-ZL1AQ, Ex-VK3ZE and 2AFJ. The camp was a great success, and for my part, I would not have minded if the camp had lasted for three months.

The secretary reports that the register of Hams on Service will be published very shortly. We are actually waiting for the final list from our representative at Richmond Aerodrome.

The meeting held during October was well attended, about 50 hams being present. The lecturer was Mr. Ross Trehearne, who spoke on "Some Interesting Phases of U.H.F. Work."

The November meeting was also well attended, between 30 and 40 hams being present. The lecturer was Mr. R. Lackey, Chief Instructor at the Australian Radio College. The title of his lecture was "Factors Determining the Choice of an Intermediate Frequency." The lecture was well received and there was quite some discussion at the end of the lecture.

Rev. W. Kennedy moved a vote of thanks to Mr. Lackey, and said that if the discussion was any indication the lecture must have aroused considerable interest. He complimented Mr. Lackey on presenting an involved subject in simple terms. The motion was carried with acclamation.

There does not seem to be much news this month, fellows. I seem to have got out of touch with things, being away for a month. Incidentally, I don't expect to be writing these notes much more, because, if I have to go to the three months' camp, I will have to resign from the

Council, temporarily at least, so that someone else can be appointed to the council to carry on the job of "Magazine Manager."

Readers will be pleased to know that the past president of the U.H.F. Section, Mr. D. B. Knock, is now a Lieutenant in 1st Div. Sigs. Also 2UP, a past councillor of the Institute, has transferred from 1st Cav. Sigs. to the A.I.F., as a Lieutenant. Mr. London was my officer in Cav. Sigs before transferring.

Just a reminder to keep the secretary informed of any change of address. He reports that the Morse classes are making rapid headway. There are at present two classes, but very shortly they will be split up into three classes.

Well, that seems all this time. Write in and let me know any news, please.

WAVERLEY RADIO CLUB NOTES.

The fact that everyone's thoughts are now turning to A.R.P. and the like probably accounted for the popularity of the film on the above phase of war work, shown at the Waverley Club during last month. This really excellent film was supplied by the St. John's Ambulance, while Arthur Henry and his brother supplied and operated the projection equipment. Other films supplied by the Shell Oil Co. and General Motors completed what all the members voted was an excellent night's entertainment.

On the 17th October, Ivan Bailue produced a small projector and took us back 15 years by screening a Felix cartoon, and what must have been one of the first "Our Gang" comedies. Realism was added by the motor breaking down, the operator having to turn the handle for the rest of the show.

Mr. W. Stewart, one of the first members of the Club, was present at the Club on the 31st October, and treated the boys to a talk on his varied experiences in the country. Varied they must have been for the chuckles haven't died down yet.

The Club still meets on every Tuesday night at rear of "Almont," 13 Macpherson Street, Waverley, and non-members wishing to keep alive the spirit of "hamdom" are cordially invited to be present.

KEY SECTION NOTES.

By VK3CX.

The November meeting of the K.P.S. was postponed for one day on account of the Melbourne Cup to enable the lads to recover after celebrating their winnings. However this did not prevent a bumper attendance, and the Institute Rooms were filled to overflowing when QW called the meeting to order at 8 p.m. Business was quickly run through to enable us to get down to the treat provided by RJ, which was in the form of an illustrated lecture on how Picturegrams are sent from Sydney to Melbourne. The pictures flashed on the screen, together with a diagram of the transmitting and receiving equipment made the lecture very interesting and easy to follow. Photos of a beautiful blonde evoked much comment, and some lads were heard asking RJ how they could get a job with her. His lecture was most instructive and as in addition, he was able to give the lads some news of 112 Mc. work, he was the hero of the night.

This lecture was followed by a demonstration of KN's new receiver—a HQ120x. Even the thought of this receiver still makes me envious, so I won't extoll its virtues, except to say that it is a humdinger of the humdingerest kind.

CZ has leave from work and is going prospecting. He hopes to persuade BQ and CP to go along with him and they have visions of striking it rich. When last seen Arthur had an armful of literature from the Mines Department and a far away look in his eyes. Yes, lads, "Thar's gold in them there mountings," and speaking of this, I hear that MR was absent from the last meeting due to an urgent appointment with his dentist that he had kept.

RX still has blonde trouble (he says "It's no trouble"), and is looking for a new flat near the beach—the accent on the last word is heavy as in "feet". CX had a hamfest of his own in the R.A.A.F., where he met about 35 hams including representatives from all States. SG can't give up his radio, and has installed his receiver at his bedside in order to hear all the dx that he is missing! BQ is still doing good work on SS receivers.

Instructive lectures are promised for future meetings, and all hams

will be well advised to keep K.P.S. meeting nights free, and turn up. A good time is assured.

QUEENSLAND DIVISION.

By 4AW.

Meetings of the VK4 Division will, in future, be held the last Thursday in each month, at the rooms of the Diggers' Association, Essex House, Adelaide Street, Brisbane. Note: The December meeting will be held on 21st and not 28th, owing to the holiday period. As mentioned in previous notes, our student classes of instruction have been discontinued, but a move is afoot to cooperate with other patriotic bodies in the matter of Radio instruction.

Country members! We would like to hear from you occasionally as to your present activities, so that we are able to keep this social column going. Our postal address remains the same.

4JB—Very busy painting.

4FB—Touring around the country looking for good portable locations. Is building a battery portable super. (Not BCL).

4UR—Concentrating on receiving code. Must be able to take 35 per now, Jack.

4UR — Likewise code swatting. Very keen on exchanging photos.

4FJ — Just been promoted in charge of Radio department of his firm. Keen on R.A.A.F.

4KS—Joining up RAAF Reserve, and putting in some time on Radio study.

4XO—In Brisbane at present, and is doing good code practice with 4KS . After commercial ticket.

4JP, 4RY and 4AW it is rumoured, have been seen indulging in golfing exercises. Judging by the swings and the language, it should not be long before they are able to take on any of the VK2 or VK3 boys.

4PX—Joining the R.A.A.F., likewise 4HD.

4WT—Just finished painting the shack and now sure looks fl.

4KH—Concentrates on the receiving side. Bill did not know there were so many S/W BC stations. Says we will be on the air again before 1940. I hope so.

4UU—Our QSL officer is complaining now of the scarcity of cards. O yeh! I still want my Yankee WAS.

4HU—Just returned from camp. Brass pounding.

4ZU and 4LT—In camp. Brass pounding.

4E1—In Brisbane—Camp.

SOUTH AUSTRALIAN DIVISION.

VK5RM.

In November, the Institute moved from its old rooms in Rundle Street to new quarters on the second floor of Chapman Buildings, in Bank Street, which is opposite the Railway Station. Code classes have been resumed and are still held every Wednesday and Friday night, and both members and non-members are welcome, the classes being free to all amateurs.

On Wednesday, November 8, Mr. J. De Cure very kindly came and gave us another code test at speeds of 12, 15, 18, 20, 22, and 25 words per minute. Each test lasted for five minutes and showed that over half of those who took the test would receive at 22 w.p.m., and about a third of them showed quite good efficiency at 25 w.p.m. On the same night, we had an unexpected visitor from the country as Clarrie Castle (5KL), who was down from Yunta, where he is an operator in VHU9, dropped in.

We wish him the best of luck and hope to see him again soon.

Some members are going to sit for the Second Class Commercial exam., which is to be held on December 5th and 6th, at the G.P.O. Study circles are being held for these members twice weekly, when they discuss the theory section of the syllabus. The code speed required for this exam. is 16 cypher groups per minute.

Professor Kerr Grant is kindly giving us a lecture on November 15 on "The Generation of High Voltages and their Use in Modern Transmission Experiments." The lecture will be given in the new rooms, and a council meeting will be held before the lecture starts.

In the new year it is hoped to start another A.O.C.P. class, covering a period of six months. Code and theory will be dealt with, as in previous classes.

QSL cards are still coming in from all over the world, and the Institute has cards for the following stations:—

VK5AG, AP, AR, BF, BG, BN, CM, CB, DY, DK, DC, DX, EM, FN, FG, FA, FX, GB, GA, GS, GN, HK, HC, HR, HS, HW, HA, JK, JG, JU, KR, KB, KX, KJ, KY, KM, LC, LS, LY, LM, LZ, LH, LO, LJ, ML, MW, MH, NL, NW, NA, RJ, RL, SL, UK, TW, WD, WM, WK, WJ, WG, XR, XL, YQ, ZU, ZK, ZR, ZN.

These stations can get their cards by sending a stamped addressed envelope to the Institute.

WHY NOT A GARDEN BATTERY?

In English "Wireless World," of July 27th, 1939, is described a novel battery for running a receiver using 1.4 volt low consumption valves. One sets to work by digging a hole one foot deep and a yard square, and laying at the bottom a sheet of zinc with an insulated wire attached. Cover with a few inches of earth and trample well down, following with a layer of crushed coke in which is embedded a number of carbon plates and rods similar to those used in large size dry cells. Connect all the rods together, fill up the hole with the remaining soil and liberally douse with salt water. It is stated that on short circuit, the "battery" will blow a five amp fuse! However, it should be remembered that, in addition to spoiling portion of the garden, the digging of the hole will show the YF you do know how to handle a spade after all.

Continued from page 10.

(B) VOLTAGE AMPLIFIERS.—The characteristics of normal output valves are such that they require relatively high values of grid excitation voltage. In cases where the detector is incapable of delivering the voltage required, or where, for reasons of sensitivity, higher gain is needed, it is usual to incorporate one or more stages of voltage amplification between the detector and the output valve.

An ideal amplifier should be capable of amplifying equally all frequencies in the audible range (approximately 30 to 15,000 cycles per second). If it fails to do so, it is said to have frequency distortion. Frequency distortion can usually be attributed to the presence in the circuit of reactive components, which, varying with frequency, tend to alter the conditions in the circuit.

Present-day requirements demand a voltage amplifier having a reasonably level response between approximately 50 and 7,500 cycles per second. Extension beyond these limits is seldom warranted, since other factors such as side band attenuation, speaker response, and effective speaker baffle area impose limitations far more serious than those likely to be encountered in the voltage amplifier itself.

One other form of distortion, which can be very serious, is that known as the "Harmonic Distortion." This refers to the tendency of an amplifier to introduce spurious frequencies which have a harmonic relationship to the frequency (or frequencies) of the applied input voltage. The average amplifying valve under ideal conditions introduces negligible distortion, but when operated under other conditions, such as incorrect grid bias or plate-load resistance, may cause very serious harmonic distortion. (It should be noted that this subject has been treated very comprehensively

in the third edition of the "Radiotron Designer's Handbook.")

The audio stage of early radio receivers used triode valves coupled by means of interstage transformers, which usually had a step-up ratio of the orders 1 : 3, or 1 : 5. Such transformers in themselves afforded useful gain, but for the most part were of relatively poor design resulting in poor quality reproduction.

With a typical general purpose triode valve, the stage gain increases rapidly as the plate load resistance is increased until this approaches a value of approximately five times the plate resistance of the valve. Increasing the load above this value then produces very little increase in stage gain.

When the plate load of a triode valve consists of the primary winding of an unloaded audio transformer, it is important that the inductive reactance of the valve at the lowest frequency, which it is desired to reproduce without serious attenuation.

For a typical general purpose triode, having a plate resistance of 10,000 ohms, the primary should have an effective inductance of not less than 20 henries. The average inductance of early transformers under working conditions was considerably less than this, and the brass correspondingly poor.

The inductance of a transformer (or choke) is dependent on three main factors:—

(a) The number of primary turns.
(b) The core material.
(c) The amount of direct current flowing through the windings.

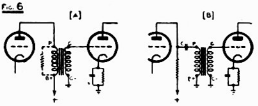
It is not practicable to continue indefinitely the addition of turns to the primary and secondary in order to obtain a higher primary inductance. As the number of turns is increased, the distributed capacitance across the windings also increases, and what is gained in bass response is liable to be lost in high-frequency response, due to the added capacitance effects. In many modern transformers the windings are wound in separate sections and arranged in such a way as to minimise distributed capacitance.

The "Permeability" of the core material has also a marked effect on the inductance of a transformer, and is, therefore, also an important factor to be considered in the design.

When direct current flows through one of the windings, it produces a uni-directional magnetic flux in the core material, which reduces the effective primary inductance. The use of a butt joint, or air gap in the magnetic circuit minimises but does not obviate this effect. One well-known make of transformer has, in the absence of magnetising current, an inductance of 260 henries, which however falls to 80 henries at the full-rated primary current of 10 milliamps.

The plate current may be isolated from the primary windings by shunt-feeding the valve. Fig. 6 illustrates (A) the conventional, and (B) the shunt-feed method of connection. With the latter arrangement, the

Fig. 6



operating conditions of the valve are quite different to those in the conventional circuit, and the output voltage available from the stage is much smaller. In cases where lower output voltages can be tolerated and the shunt-feed connection used, the resulting increased inductance usually enables better frequency response to be obtained. Under these conditions, the coupling condenser

Royal Australian Air Force

VACANCIES FOR WIRELESS OPERATORS

Applications will be received from amateurs in all States.

Details of enlistment from the Secretary, Air Board, or W.I.A. Divisional Headquarters.

Apply at once by mailing the form below.

The Secretary,
Air Board,
Victoria Barracks,
MELBOURNE, S.C.1

I wish to enlist in the Royal Australian Air Force as a Wireless Operator. My age is .... years*, I hold the A.O.P.C. and can send and receive at .... w.p.m.* I am available for immediate war service.

Signed ....

Address ....

....

Date ....

***Age limits are 18 to 35 years and minimum operating speed is 16 w.p.m.**

NOTE 1.—Enclose separate sheet giving full details of qualifications, etc.

NOTE 2.—Persons who do not possess the above qualifications, but who are desirous of enlisting for training as wireless operators may do so by applying to the above address stating full particulars.

"C" should have a reactance which is small in comparison with that of the transformer primary at the lowest frequency to be reproduced. In general, for a transformer of given primary inductance, the bass response may be adjusted, within certain limits, by using a coupling capacitance of such a value as to give a suitable resonant frequency with respect to the lowest frequency to be reproduced. For an even bass response the resonant frequency should be chosen below the latter.

It will be seen from the foregoing discussion, that even for general purpose triodes, the design and production of interstage transformers having a good frequency characteristic are by no means simple.

High gain triodes, such as type 6B6-G, have a relatively high-plate resistance and are not suited to transformer coupling, since the requirements of high inductance and low distributed capacitance are such that satisfactory transformer design is impracticable.

For the same reason, transformer coupling is also unsuitable for use with tetrode or pentode voltage amplifier valves.

When for some reason it is necessary to use a transformer having insufficient primary inductance, the variation with frequency of the plate load impedance of the associated valve may be reduced by loading the primary or secondary with a resistor as shown in Fig. 6A.

With few exceptions modern receivers use resistance coupled voltage amplifiers. In the main resistance coupling has the advantage of cheapness and the ability to provide an even response over a wide frequency range. In addition, the chances of hum pick-up are minimised with the elimination of large iron core inductances, which tend to pick up by induction hum voltages from the power transformer and filter chokes.

Modern high gain triodes, when resistance coupled are capable of providing stage gains comparable to those of normal transformer coupled stages. Resistance coupled pentodes, however, such as type 6J7-G, working under optimum conditions are capable of providing higher stage gains than those obtainable from triodes, with better fidelity and less distortion. The actual voltage output capability (for a given plate supply voltage) is usually less than that of transformer coupled stages, although, in the majority of cases, it is ample for all requirements. Figs 7 and 8 show typical circuit arrangements for triode and pentode resistance coupled stages respectively.

Special circuits are necessary when it is desired to excite push-pull output valves, and some designers prefer to use in this case a push-pull audio transformer.

It is beyond the scope of this lecture to investigate fully the design of resistance coupled amplifiers, but

Fig. 7

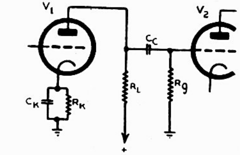
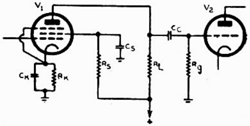


Fig. 8



a consideration of certain aspects may be of value.

The maximum D.C. plate voltage rating of a valve refers to the maximum permissible D.C. voltage which may be applied between plate and cathode. With resistance coupling, the supply voltage may be made equal to approximately twice the rated plate voltage, due to the voltage drop which occurs in the plate-load resistor. For a given percentage distortion, the maximum output voltage of the stage increases with the supply voltage.

It has already ben pointed out that the stage gain with a normal triode increases rapidly with the plate load resistance until the latter approaches a value of approximately five times the plate resistance of the valve, beyond which point further increase in load resistance produces little increase in gain. It is desirable, therefore, that the value of the plate-load resistor should be at least five times the rated plate resistance of the valve.

There are, however, other factors which must be considered. It can be shown that the grid resistor (Rg), which, for audio frequencies, is effectively in shunt with the plate load resistor (Rl), has a marked effect on the performance of the stage, tending to reduce the output voltage capabilities and stage gain, and increase the distortion. The grid resistor (Rg) should have, therefore, preferably at least five times the resistance of (Rl), but in practice its value is limited by the maximum permissible grid circuit resistance of the valve V2. For the majority of power output valves, this resistance is .5 megohm under self-bias conditions. The final choice of Rl therefore must be a compro-

mise between optimum load and the ratio of Rg to Rl. For high gain triodes (e.g., type 2A6) or pentodes, which have high values of plate resistance, the usual value of load resistor is .25 megohm. With lower gain triodes, having plate resistances of the order of 10,000 ohms, a plate load resistor of .05 to .1 megohm is satisfactory.

The capacitance of the coupling condenser (Cc) depends mainly on the value of Rg. At low audio frequencies the reactance of condenser (Cc) rises and tends to cause loss of response. The following table shows the recommended values of capacitances of coupling condensers (Cc) for various values of grid resistors (Rg). At first sight, the values may appear to be excessive, but it should be remembered that where several such couplings are used, as may be case in a multistage amplifier, any losses so introduced are cumulative, and may result in a poor overall frequency response. In a simple receiver the coupling condensers may be reduced with negligible loss to one half the values shown.

Grid Resistor (Rg)		Coupling Condenser (Cc)	
2	megohms	.01	Microfarad
1	,,	.02	,,
.5	,,	.05	,,
.25	,,	.1	,,
.1	,,	.25	,,
.05	,,	.5	,,

Where Rg is limited by circumstances to .05 megohm (50,000 ohms) (e.g., as in the case of certain power valves when operated under fixed bias conditions), the plate load resistor Rl of the preceding valve should preferably not exceed 25,000 ohms, so that a valve having a very low plate resistance is required for the voltage amplifier stage.

The operating conditions of a pentode voltage amplifier are more critical than a triode, in that one more factor has to be considered, namely, the screen grid voltage. The overall performance, however, is superior to a triode in most applications, for which it is advisable to adhere rigidly to the recommended operating conditions, as listed in Radiotronics Bulletin No. 76, and also in the loose leaf Radiotron Valve Data Book under "Resistance Coupled Pentodes."

The capacitance of the screen bypass condenser (Cs), at the lowest frequency which it is desired to reproduce, should be such that its reactance is very small compared to the resistance of the screen dropping resistor (Rs). The value of Cs may be .5 microfarad when Rs is 1 megohm or less ,and .25 microfarad for values in execess of 1 megohm.

For obvious reasons, the condensers Cg and Cs should both have extremely low leakage, as even a few micro-amps. of direct current through the associated high value resistors can vitally affect operating conditions of the valves and lead to serious distortion.

(C) GRID SUPPLY VOLTAGE.— Except in special cases, the grid of an amplifying valve must be maintained at a potential which is negative with respect to the cathode or filament. The actual value of this "grid bias" is, of course, dependent on the valve type and the particular conditions of operation. The bias may be applied in one of two ways. If the filament or heater is maintained at earth potential, the grid return may be made to a point which is negative with respect to earth. Alternatively, the grid may be returned to earth and the cathode or filament made positive with respect to earth.

In battery receivers where the filaments of a number of directly heated valves are connected in parallel, the latter scheme is not usually practicable, as individual requirements of bias for the various valves can-

not be satisfied. When the filaments are wired in series-parallel and operated from a higher voltage source (as in some vibrator receivers), the problem is different, and it is frequently possible to arrange the circuit so that each valve receives its correct bias. Particularly useful in this respect are the Australian type 1M5-G, and the type 1C7-G, which may be operated without negative grid bias.

In the majority of battery receivers, it is simpler to connect the negative side of the filaments directly to earth and apply the bias in the grid circuit. The bias voltages required may be obtained either from a "C" battery, or from a suitably tapped resistor connected between the negative side of the high tension supply and earth. With the latter arrangement, some form of grid circuit decoupling is frequently necessary to prevent feedback through the bias network.

It should be noted, that the rated grid bias of a battery valve refers to the D.C. potential difference which should be applied between the grid and the negative filament pin, which is usually connected to earth. Incorrect connection of the filament battery has therefore the effect of reducing the bias by an amount equal to the filament voltage. With directly heated valves intended primarily for A.C. operation, the grid bias, unless otherwise specified, is measured between the grid and the mid-point of the filament.

In mains receivers, designers have the choice of using back-bias or self-bias. With back-bias, the cathodes of the valves concerned are directly earthed, and the grids returned to suitable tappings on a resistor connected in series with the negative arm of the high tension supply. With such an arrangement, it is possible to eliminate entirely the need for separate cathode bias resistors and condensers.

The self-biasing method utilises the voltage drop produced by the cathode current flowing through a resistor connected between the cathode and earth. The direction of this current is such that the cathode becomes positive with respect to earth and therefore to the grid,

which is returned to earth. The cathode current is equal to the plate current in the case of a triode, or to the sum of the plate and screen currents in the case of tetrodes and pentodes.

When an alternating voltage is impressed across the grid input circuit the cathode current does not remain constant but varies at the frequency of the applied voltage. The resulting voltage developed at the cathode is in phase with the applied grid input voltage and tends to reduce the potential difference between grid and cathode. This is equivalent to a reduction of stage gain, and the method is one form of applying degeneration (or negative feedback). This degeneration may be minimised by connecting across the resistor, a condenser having a capacitance such that its reactance, at the particular frequency or frequencies concerned, is small compared with the value of the resistor. In R.F. or I.F. stages, conventional capacitance employed are of the order of .1 microfarad. In the case of audio amplifiers, however, the value has to be very much higher and electrolytic condensers having capacitances from 10 to 25 microfarads are generally used. If the capacitance is too small it is effective only at the higher frequencies, and leads to loss of bass response. The gain of the average stage without the condenser is about one half of that with the condenser in place.

Self-bias is most satisfactory in cases where the average cathode current is substantially constant for all values of grid input voltage. In power amplifiers in which the average cathode current varies with the grid input level (e.g., under conditions of overbiassed or Class AB1 operation), the use of self-bias produces a drop in power output. In extreme cases, as with class B output stages, self-bias is quite unsatisfactory.

(To be continued).

HAMS!

DO YOU WANT TO BE BACK ON THE AIR?

The Wireless Institute of Australia

is the recognised spokesman of the AUSTRALIAN AMATEUR.

If you are not a member——

Join Now!

When the time comes that we can reasonably expect to go back on the air, we want to say that we represent——

EVERY ACTIVE HAM

in the Commonwealth.

Strengthen our hand by writing to The Secretary of the Institute in your State to-day.

All addresses are on the title page.

HAMADS

Advertising space in these columns is available to those wishing to sell buy or exchange.

RATES.

General 6d. per line (minimum 5 lines).

Institute Members—
Commercial, 4d. per line (minimum 5 lines).

To sell, buy or exchange used equipment, 3d. per line (minimum 4 lines).

To ensure insertion enclose remittance with copy and address to The Editor, Box 2611W G.P.O., Melbourne, or Large and Powers, 422 Collins Street, Melbourne.

It is reported that the cables supporting the balloon barrage around London are seriously interfering with UHF transmissions, especially the BBC television transmissions.

AMATEUR RADIO REGISTER

The Federal Headquarters of the WIA has decided to take a National Register of Radio Amateurs so as to ascertain the degree of National effort of which we are capable as well as to gain some definite knowledge of the extent of the Australian Amateurs participation in the War.

The value of the Register as an illustration not only of potential resources, but also of the precentage of Amateurs already serving can readily be seen. To be worthwhile, however, it is essential that the fullest co-operation is received, thus you are earnestly requested to forward your Register form immediately to "Amateur Radio," Box 2611W, G.P.O. Melbourne.

It is to be strictly understood that this Register is entirely unofficial and that the forwarding of the Form, duly filled in, commits the Amateur concerned in no manner whatsoever.

AMATEUR RADIO REGISTER

NAME ....

ADDRESS ....

DATE OF BIRTH................. **OCCUPATION**...........................

PHYSICAL CONDITION..

CALL.................... **OPERATING SPEED**................................

RADIO QUALIFICATIONS ....
(Other than A.O.C.P.)

Details of PAST MILITARY EXPERIENCE (if any).......................

ARE YOU SERVING OR UNDER OBLIGATION TO SERVE WITH ANY BRANCH OF THE FORCES AT THE PRESENT TIME ? (Give Full Details) ....

....

....